



ECOLOGICAL STUDIES ON THE NATIVE GRASSES
OF THE GRANDE PRAIRIE-BEAVERLODGE DISTRICT.

by

E. Clifford Stacey.

A Thesis

Submitted to the University of Alberta in partial
fulfilment of the requirements for the Degree of
Master of Science.

Edmonton, Alberta
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THE GRANDE PRAIRIE-BEAVERLODGE DISTRICT

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ECOLOGICAL STUDIES ON THE NATIVE GRASSES OF THE GRANDE PRAIRIE-BEAVER LODGE DISTRICT

I INTRODUCTION

The native vegetation of the prairie provinces has as yet received little attention from the ecologist. Some work has been done but considering the amount there is to be done it might be said that not more than a mere start has been made. Jackson, of the Manitoba College of Agriculture, has studied the successions of the Red River Basin (10). Lewis and Dowding, of the Department of Botany, University of Alberta, have published a paper on "The vegetation and retrogressive changes of peat areas (muskegs) in Central Alberta" (1926). Apart from the findings of these investigations all that is known of the native ecology of the prairie provinces is based on the observation of a few botanists who have casually visited the district. Among these are Macoun, Malte, Clements and some of his co-workers of the Carnegie Institute of Washington, and possibly others.

General Vegetational Formations in Alberta.

In general there are five formations recognised in Alberta. The vegetation of the south-east corner of the province belongs to the "mixed prairie" formation. Adjoining this is a broad stretch of "true prairie" which extends westward to the foothills and north as far as Olds and Coronation. Apparently these correspond to formations of the same name in

one to several townships.

The Purpose of the Investigation.

In 1925 under the direction of the Department of Field Husbandry of the University of Alberta and the Dominion Experimental Farm System a survey of one of these areas, the Grande-Prairie-Beaverlodge district was undertaken. The ultimate aim of this survey is to determine the agricultural possibilities of the district as indicated by the natural vegetation. In order to determine the significance of the native vegetation the ecology of the area must be worked out and the findings related to those of other districts where the relation of climate and natural vegetation to agriculture has been conclusively studied.

Since a complete study of the district involves a project of considerable magnitude it was decided to limit the present undertaking to an investigation of the climatic and ecological relations of the native grasses.

II DESCRIPTION OF THE DISTRICT

Location.

Since the experimental Farm at Beaverlodge, latitude $55^{\circ}10'$, longitude $119^{\circ}19' W$, is centrally located in the area this point was used as the base of operations and it was necessary to limit the extent of the territory to points which could be reached fairly conveniently. This made it possible to include a definite section of the district which had been settled. This section is approximately 45 miles long and 25 miles wide and extends from the town of Grande Prairie to about 15 miles west

of Beaverlodge, south to the Wapiti river and North to Valhalla.

Drainage.

The district is drained by the Wapiti river and its tributaries. East of Grande Prairie the Wapiti flows into the Smoky which, in turn empties into the Peace River near the town of Peace River. The Red Willow river enters the district from the west and after following a winding course flows into the Wapiti about 12 miles south of Beaverlodge. The Beaverlodge river, usually not more than a good sized creek, flows through several lakes at the north-west corner of the section and from there in a general south-easterly direction until it joins the Red Willow a few miles before the latter joins the Wapiti. The only other stream of much importance is Bear Creek. This runs parallel to the Beaverlodge river and drains the north-east portion. After passing through Bear Lake and Grande Prairie it flows into the Wapiti.

Numerous lakes dot the country. The most important of these are Bear Lake and Lake Saskatoon. There are many others but they are not sufficiently important to warrant mention. As shown in Figure 5 they are widely scattered and together with the intermittent streams which take care of the melted snow in the spring have an important bearing on the floral aspect of the section.

TOPOGRAPHY

At the north and west the general level of the land is about 2600 feet. From here there is a general slope in a south-easterly direction until the vicinity of Bear Lake and

Grande Prairie the country lies below the 2200 foot contour level. In the center of the district a butte-like formation rises to slightly over 3000 feet and covers about one township. Near the top the rise is rapid, but the base extends for considerable distances. To the north-west it merges into the higher level found there. In other directions the slope is a little steeper with the result that to the west and south the valley of the Beaverlodge extends into a broad plain. The only other exception to the general slope of the land is along the Red Willow and Wapiti rivers. The bed of the Wapiti is below the 2000 foot level and the banks on either side are high and steep. On the average the 2200 foot contour lies within a mile of the river. The banks of the Red Willow are not as high but are of the same general type. Within about 15 miles there is a drop from 3000 feet on Saskatoon Mountain to about 2000 feet along the Wapiti river. This is quite steep but is the greatest to be found in the district. As would be expected, due to the numerous streams and lakes, the country is generally rolling except for the extreme variations mentioned above. In this regard it is no doubt similar to the nearby areas featuring the same type of vegetation.

The Soil.

The average type of soil is a sand or clay loam five to six inches deep. Immediately below this is a streak of greyish silty material which usually overlies the clay subsoil. The top soil of the Grande Prairie-Wembley region is not as heavy

as in nearby districts, a condition which results in the evidence of lack of available moisture appearing here before it does elsewhere.

South of the Red Willow river the greyish silty material is quite close to the surface. In the native state this soil appears to be light and unproductive but after it has been cultivated for a few years the light color partly disappears.

Considerable areas along the Wapiti river are covered with sand ridges. The sand is covered with only one or two inches of loam and often the vegetation is scanty.

The Vegetation.

As mentioned above this area lies within a forest formation, possibly the northern mixed forest since the vegetation seems to resemble this rather than the Cordillerian forest. This formation crosses the Wapiti at the south. In general its eastern boundary corresponds to the line of the 2600 foot contour at the west end of the district. Within the district, centering on Saskatoon Mountain, it covers about three townships. The remainder is parkland and presents a decided contrast to the forest formation. The exact relationship of these two is very indefinite, and depends on local topography and moisture conditions. Along each creek or lake are successions of spruce, poplar, willow, and grassland. In Figure 5 the central portion is predominantly grassland while the portion between this and the forest formation is covered in varying degrees with poplar or willow.

III LITERATURE

This investigation is pioneer work for this district and consequently there is no literature bearing directly on the sub-

ject. It is possible, however, to use literature dealing with similar conditions in other districts to interpret present findings as will be done later.

IV METHODS OF INVESTIGATION.

The methods adopted in studying this problem consisted of field trips, the collection and identification of specimens, the tabulation of the meteorological data, and a study of the revelant literature. For convenience the more intense work was done in the immediate vicinity of Beaverlodge where suitable locations were to be found. Often it was necessary to go further afield. The area extending from the flood plains and backwaters along the Beaverlodge river directly west of Beaverlodge eastward to the top of Saskatoon Mountain, Lake Saskatoon Island and the area adjoining on the west, and several small areas south of Beaverlodge were studied in greatest detail. The remainder was covered as thoroughly as time and convenience would permit. At best this consisted of little more than a general survey.

A portion of the summer of 1925 was spent in reconnaissance, making general observations and collecting a few specimens. During the University session of 1925-26 some time was spent in identifying the specimens collected.

During the next summer most of the field work was done. This, as before, consisted of making observations and collecting specimens. During the session of 1926-27 the specimens were identified. Representative samples of each species of

the grasses and some of which the identity was doubtful were sent to Dr. Hitchcock, Washington, for authoritative naming. The specimens of sedges and Juncus were sent to Mr. Kenneth McKenzie, New York.

During the same period an analysis of the meteorological records of the Experimental Farm at Beaverlodge were made, special attention being directed to those phases of the climate which have an important influence on the native vegetation. In most cases the records extend over the period from 1916 to the present. Meteorological data for the town of Grande Prairie are also available but since these are very similar to those obtained at the Experimental Farm, the stations being only 28 miles apart, no advantage will be gained by using the former. Similarly temperature and precipitation data are being recorded by several observers throughout the district but these records would be of little use here since they do not cover a period of years.

To illustrate the more important phases of the climate tables and graphs were made. Similarly maps were prepared to show the relation of the vegetation to the topographical features of the district and the relation of the district to adjoining districts. The more important of these are shown here (Figs. 4 and 5).

The literature was carefully examined and attempts were made to relate any findings, both climatic and floristic, to similar conditions existing elsewhere. In other places, particularly in the United States, considerable work has been done in relating the native grasslands to agricultural pract-

ices. Such work can be used as a guide in an investigation like this.

V DATA ON CLIMATE

Temperatures

Mean Annual Temperature

Over a period of eleven years the mean annual temperature was 35.04° F. The lowest recorded was for 1917 when the average was 32.33° . The highest, 38.79° , was for 1926. This is exceptional, the next highest being 37.72° for 1923. An examination of the records for 1926 (see Table IV) show that the average temperature for the first two months of the year was exceptionally high. January had a mean temperature of 27.09° which was approximately 20 degrees above the average for the period. February of the same year had an average temperature of 25.35° or 10.26 degrees above the average. March and April had correspondingly high temperatures. While these are extreme they are lower than those for other parts of the same country and comparable with those over the whole of Western Canada.

Mean Summer Temperature

While the mean annual temperature gives a general impression of the temperature of the entire year it is not so important a measure as the mean summer temperature. The summer months are generally considered to be June, July, and August but in this district the temperature of May is very important. A cool May with frequent frosts has an important bearing on the native vegetation as well as on agricultural crops. Ac-

cording to the usual grouping the mean summer temperature is slightly above 57° while if May is included it drops to about 55° . As shown in Table V June, July, and August have minimum temperatures of approximately 43° , 47° , and 45° , respectively. On the other hand the minimum temperature for May drops to less than 36° . Although the average maximum temperature for the month is 61° little growth is to be expected since the tendency is for the warmer portion of the day to be short at this season. The same applies to September. If the summer months were taken to include both the mean temperature figure would be correspondingly lowered.

Mean Annual March of Temperature.

The march of temperature from month to month throughout the year is shown graphically in Figure 3. This shows the hottest and coldest months as well as the mean temperature for any month. It also shows the period of the year during which growth may take place.

Absolute Annual Range of Temperature.

The absolute annual range of temperature is the difference between the highest and lowest temperatures of the year. This range, see Table VI, gives an index of the severity of the climate. Usually, however, other factors such as the amount and distribution of the snow cover modify the effect of the temperature.

Length of the Frostless Season.

Many complicating factors, which will be discussed later,

tend to make the data as usually presented under this heading practically worthless when applied to this district. About all that can be said is that throughout most of the district, especially the more open parts, Marquis wheat usually ripens safely in the upland districts. In the other parts only the earlier varieties are considered safe.

Precipitation.

Variation in Annual Precipitation.

In common with most parts of the West there is a great variation in the amount of precipitation from year to year. When based on the crop year, August 1st to July 31st, the average rate is 16.46 inches. The season of 1920 was the wettest on record, the precipitation being slightly more than 25 inches. Only in two years, 1923 and 1924, was the amount less than 14 inches, the amounts being 11.84 and 8.24 inches respectively.

Distribution of Precipitation Throughout the Year.

As shown in Figure 2 and Table I the distribution of rainfall over the period is characteristic of the continental type. June, July, and August are usually the wettest months.

Snowfall.

The variation in annual snowfall is as great as is the amount of total annual precipitation. As would be expected there is an apparent correlation between the two, the years of lightest snowfall being the years of least rainfall. The average for ten years is about 71 inches but the yearly amounts vary from 36 to 120 inches. In the last two years there has been fairly heavy snowfalls in September. In other years al-

though some might have fallen in this month the amount was so small that it was more convenient to report it in terms of rain. In 1924 very little was recorded before the month of December.

In the spring there is usually a light fall in April. In 1917 and 1922 falls of 10 inches were recorded in May. June, 1926, broke all records, 22.7 inches being recorded. While snowfalls in the late spring or early summer may be harmful to trees and similar vegetative forms they are usually very beneficial to the lower growing vegetation since the runoff is very small.

To supplement the data on snowfall Table III showing the number of days sleighing each month has been added. This data is accurately obtained for each season and since sleighing conditions depend on temperature and the amount of snow lying on the land the data will generally conform to the period during which there is sufficient snow covering to protect the vegetation. The only exception is when knolls and ridges are bared of snow in the winter due to the effect of Chinook winds.

Humidity.

The rate of water loss from the surface of plants is largely determined by the relative humidity of the air. This depends on such factors as temperature, wind, air pressure, exposure, and cloudiness. Data concerning some of these factors are included here but for others they must be determined for each habitat. The rate of evaporation from a free

water surface (Table VII) is considered to be a general index of the humidity of the air. The evaporation loss from living plants will vary as the evaporation from a nearby free water surface. Lacking more minute data this information gives some conception of the possible efficiency with which the precipitation may be used.

Sunshine.

The extreme length of day during the growing season in this district is one of the most important of the biological factors. From a possible of 15.2 hours sunshine on May 1st the length of day increases until a maximum of 17.5 hours is reached by the end of June after which a corresponding reduction takes place. The actual number of hours of bright sunshine recorded for the last three years is given in Table X. The difference between the possible and the actual amount is due to cloudy weather or the presence of a smoke screen dense enough to obscure the sun.

VI DATA ON NATIVE VEGETATION

As mentioned before the study of the native vegetation has been limited to grasses as they are found in their natural state. Occasionally it will be necessary to mention other forms, especially when the latter tend to modify the conditions under which the grasses grow. The references in such cases must be considered only general and are included only where necessary.

The associations considered here are grouped in three classes: the lowland grass associations, the upland grass associations, and those that are found in the woodland transition.

The Lowland Grass Associations.

These associations reach their development in shallow lakes, ponds, drained and undrained depressions in upland or sand ridge areas, or in connection with the development of the stream system. The important associations are:

- 1 Calamagrostis-Pannicularia
- 2 Agrostis-Poa palustris
- 3 Poa pratensis
- 4 Carex spp.

The following species are found in these associations:

<u>Pannicularia grandis</u> (S.Wats.) Nash	1*
<u>Calamagrostis canadensis</u> (Michx.) Beauv.	1*, 2
" <u>inexpansa</u> A. Gray	1, 2
<u>Beckmannia eruceaformis</u> L. (Host.)	1, 2
<u>Phalaris arundinaces</u> L.	1, 2
<u>Alopecurus aequalis</u> Sobol	2,

Note. The numerals preceeding the names indicate the association or associations, listed in the foregoing paragraph, in which the species is usually found. Dominant or very abundant species are indicated by an asterick (*).

<u>Aira caespitosa</u> L.	2,
<u>Hordeum jubatum</u> L.	2, 3
<u>Agrostis hiemalis</u> (Walt.) B.S.P.	2*, 3
<u>Poa pratensis</u> L.	3*
" <u>palustris</u> L.	2*
" <u>interior</u> Rydb.	3
<u>Carex lanuginosa</u>	2
" spp.	4
<u>Juncus nodosus</u>	1

The Upland Grass Associations.

These associations occur in the drier meadows, in typical upland situations, and in exposed places. The associations are:

- 1 Poa pratensis
- 2 Poa-Agropyron
- 3 Koeleria-Agropyron
- 4 Elymus innovatus

The following species are found in these associations:

<u>Calamagrotis inexpansa</u> A. Grey	2
<u>Hordeum jubatum</u> L.	1
<u>Agrostis hiemalis</u> (Walt.) B.S.P.	1, 2, 3,
<u>Poa pratensis</u> L.	1*, 2
" <u>palustris</u> L.	1, 2
" <u>interior</u> Rydb.	1, 2*, 3
" <u>compressa</u> L.	3,
<u>Avena hookeri</u> Scribn.	2,
<u>Melica purpurascens</u> (Torr.) Hitchc.	2,

<u>Stipa columbiana</u> Macoun	3
" <u>spartea curtiseta</u> Hitchc.	3
<u>Elymus innovatus</u> Beal	2, 3, 4*
<u>Torresia odorata</u> (L.) Hitchc.	2
<u>Agropyron tenerum</u> Vasey	2* 3
" <u>smithii</u> Rydb.	2, 3
" <u>caninum</u> (L.) Beauv.	1, 2* 3
" <u>inerme</u> (Scribn. & Smith) Rydb.	3
" <u>albicans</u> Scribn. & Smith	3
<u>Koeleria cristata</u> (L.) Pers.	2, 3*
<u>Carex praticola</u> Rydb.	2
" <u>lanuginosa</u> Michx.	1
" <u>xerantica</u> Bailey	2
<u>Juncus aster</u> Rydb.	2
" <u>Vaseyi</u> Engelm.	2

The Woodland Transition.

This includes the species found in habitats which are directly affected by the woodland trees and shrubs. The latter modify such factors as moisture and light and the presence or absence of the following species will depend on their relations in this regard.

Calamagrotis canadensis (Michx.) Beauv.

" inexpansa A. Gray

Aira caespitosa L.

Hordeum jubatum L.

Agrostis hiemalis (Walt.) B.S.P.

Poa pratensis L.

" palustris L.

" interior Rydb.

Poa compressa L.

Avena hookeri Scribn.

Melica purpurascens (Torr.) Hitchc.

Elymus innovatus Beal.

Cinna latifolia (Trevir.) Griseb.

Bromus ciliatus L.

Agropyron tenerum Vasey

" smithii Rydb.

" caninum (L.) Beauv.

Carex praticola Rydb.

" atratiiformis Britton

VII DISCUSSION OF CLIMATIC FACTORS

Basis of Precipitation Studies

It has recently been shown that the greatest correlation between the total amount of precipitation and the wheat yields for the Edmonton and Lacombe districts of Central Alberta is to be had when the year is taken to be from August 1st to July 31st(#). Since these districts have essentially the same distribution of precipitation and natural vegetation as the Grande Prairie-Beaverlodge district it is reasonable to suppose that a similar correlation could be obtained for the latter district if there were sufficient records available.

(#) Note - Unpublished paper of Dr. R. Newton presented at the meeting of the Western Canadian Society of Agronomists, Edmonton, December, 1926.

The precipitation data is consequently presented on this basis. The native vegetation makes similar demands on the moisture supply to that of the spring wheat crop. With the wheat crop a shortage of moisture from May to July results in a poor crop. With grasses a similar condition produces only a scanty growth for that season and if the same conditions exist over a period of years species with more xerophytic tendencies may be expected to replace species already present. The rainfall after the first of August may have an effect on the vegetative growth but has little effect on the distribution and prevalence of the various species.

Effectiveness of Precipitation

Precipitation data must be interpreted in terms of its effectiveness. Factors such as temperature, relative humidity, wind movement, etc., have a definite influence on the amount of moisture that is lost by evaporation and the amount that can be used by the plant. The amount of precipitation that produces "true prairie" conditions in Alberta would produce only "short grass" or "desert scrub" in the Great Plains.

Kincer (11) states that the warm season pan evaporation in the northern portion of the United States is slightly more than 30 inches as compared with about 60 inches in the south. While the ecological significance of this data stated in terms of equivalent rainfall for the different areas can be obtained only approximately, he considers that probably the difference of 30 inches in evaporation between the north and south is equivalent to about 10 inches of annual rainfall.

The evaporation of the Grand Prairie-Beaverlodge district over a period of five years averages 19 inches. If the same relationship holds between this district and those mentioned above the average annual rainfall of 16.5 inches of this district is at least as effective as 20 inches in the northern United States.

By assuming further that towards the central portion of the United States the rainfall is slightly less efficient than it is in the northern part it would seem that as regards precipitation the Grande Prairie-Beaverlodge district has about the same climate as the eastern parts of North Dakota, South Dakota, Nebraska, and of central Kansas. Similarly the effective summer precipitation is approximately the same as for these districts.

Distribution of Rainfall Throughout the Year.

The average monthly distribution of precipitation as shown in Figure 2 would indicate that the first part of the growing season is dry and that June, July, and August are relatively wet months. April is the dry month of the year but since the top soil is usually soaked with melted snow at this time, rain is not needed. By the last week of April or the first week of May the extra moisture from the spring thaw has either followed the frost level downward or has been evaporated by the usual spring winds and the top soil is dependent for moisture on either rain or light snowfalls. On a nine year average the rainfall for May is 0.88 inches. This in itself is enough to carry the vegetation over this

period. In three years the amount of May rain has been less than half an inch. This leaves the soil rather dry and unless heavy rains come early in June there is likely to be very poor growth. In 1922 over two inches fell in this month.

It will be noted that the average for this month is based on a nine year period instead of ten years as for the other months. The reason for this is that in May 1917, 6.62 inches of rain fell and since this is much greater than the amount for any other year it cannot reasonably be included in the average. Practically as much rain fell at that time as has fallen in all the months of May combined since that time.

If there is a fair distribution of rain in June and July normal growth can be expected provided conditions have not been too dry in May. Usually there is about an inch in May and two inches in each of June and July. Considering the relatively high efficiency of the rainfall this tends to produce good growing conditions. Occasionally it is wetter than this with a corresponding vigor of growth. In 1926 there was slightly more than an inch in May followed by 4.45 inches in June, half being snow which lay on the ground for about five days. In July two inches of rain fell. This extra precipitation resulted in the production of a grass cover which was unduly heavy.

In contrast to this the season of 1924 was very dry. The rainfall for April, May, and June was 0.15, 0.45, and 0.60 inches respectively. July was normal and 4.6 inches fell in August. The native vegetation had to depend on the residual soil moisture to carry it over the first part of the summer until the August rains came. These enabled the plants to recuperate and

prepare themselves to pass the winter. A few successive seasons like this would probably have an important influence on the flora of the district. Such extreme conditions are rather uncommon.

From this it must not be understood that each season is similar to either of the two described above. These are the most extreme years for which records are available. Moisture conditions for the other years are nearer to the average. It must, however, be admitted that extreme moisture conditions do occur. Probably the varying conditions from season to season within the year are more important than the yearly fluctuations. Whether these extremes are greater than those which occur in other parts of Western Canada is not known. Judging by the variability in the yields of agricultural crops from year to year and district to district it would appear that such is not the case.

Precipitation Compared with That of Other Districts.

It has been stated before that the average monthly distribution of precipitation is similar to that of the Edmonton and Lacombe districts. It is distinctly of the continental type as opposed to the coastal type characterized by heavy winter and light summer rainfall.

It is in some respects similar to that of the regions of the Great Plains where the "true" or "mixed prairie" is found. The only difference between these latter two is in the total amount. According to Clements the "true prairie" regions usually have 25 to 40 inches while the "mixed prairie" regions have 15 to 25 inches. Since the "true prairie" districts of North Dakota and Minnesota have about 20 inches and the more southern parts have somewhat more it would seem that as far as the effective precipitation and distribution is con-

cerned the conditions are similar in the "true prairie" regions to those of the Grand Prairie-Beaverlodge district.

Temperature.

From its geographical position, being about 400 miles north of the International border and only 100 miles from the Rocky Mountains temperature conditions would be expected to be quite severe. The average yearly and summer temperature are slightly lower than they are further south but the difference is not as much as would be expected. The lowest temperature reported since 1916 at the Experimental Station, Beaverlodge, is -52° F. Each winter temperatures of from -35° to -45° can be expected but only very occasionally does this condition last for more than a day or so at a time. Alternating with the cold spells during the winter months are periods during which the warm Chinook winds cause a rise in the temperature, frequently with the effect of removing part of the snow cover several times during the winter. As a result of the alternating cold and mild periods the average temperature for the months of December, January, and February is only 10° F. In the northern Great Plains the same average is found in the district comprising north-east Montana, central North Dakota, and central Minnesota (11).

The mean temperature for June, July, and August is 57° . This is considerably lower than the average for same season for the Great Plains generally. There seems to be a general reduction northward in summer temperatures from a mean of about 65° in northern Montana and northern North Dakota.

The relatively low mean temperature of the Grande-Prairie-Beaver-lodge district is to be accounted for by the cool nights. Extremes of from 85° to 91° cause rapid growth and high evaporation rates but the average maximum temperature of 69° is productive of conditions favorable to normal growth. The average minimum temperatures for the same period range from 43° to 47° . If these were lower there would be a probable occurrence of frequent frosts. The low night temperatures are no doubt the reason of the low evaporation rates and the absence of the more tender species from the flora.

In the month of May the average minimum temperature is 35.5° . This indicates that for about half the days minimum growing temperatures are reached. At the same time the maximum temperatures average 61° . The effect of these temperatures is likely to be more pronounced in the growth of field crops than the native grasses. The latter take advantage of the warm period during the daytime but are not affected by the cool night temperatures.

Evaporation.

The data on evaporation is based on readings from a free water surface at approximately ground level. Owing to difficulties encountered by the action of frost it is only practicable to obtain this data during the frostless season. Consequently there is a short period in the spring and fall during which some evaporation takes place but the amounts are insignificantly small.

The data on the monthly evaporation rates does not readily lend itself for tabulation but since this is such an important

factor it is presented in Table VII. For comparison similar data for Ft. Collins, Colo., (altitude 4985), as reported by Robbins (15) is presented in Table VIII. Even at a fairly high altitude there is considerable evaporation during the winter months in Colorado. The July evaporation is high but not significantly higher than at Beaverlodge. In the other months the increase or decrease is fairly uniform.

The Beaverlodge data shows that June and July are months of high evaporation. The rate for August is considerably lower. In September there is a corresponding decrease and little evaporation takes place in October. It is true that the period August to October tends to be wet but the averages do not show that there is enough wet weather to reduce the evaporation so markedly. August is a wet month but no more so than July. While the records (Table V) do not show striking differences in temperature experience has indicated that by the last of August there is a rapid lowering of the temperature. Figure 3 shows that during September and October the decrease is even more marked. The wet weather of August accompanied by cool weather in the latter half of that month together with the low temperatures of September and October satisfactorily explain the low evaporation rates of this period.

The evaporation rate for the month of May is higher than would be expected. For the five year period the data is available for an average of the last 26 days of the month. If calculated for the entire month the rate for May is 4.3 inches or as about much as that of July and considerably more than for June. May is a dry month but the prevailing low temper-

atures should reduce the evaporation considerably. Apparently the wind and the small amount of rain in this month more than offset the effect of the low temperatures. This appears to be the only possible explanation.

Sunshine.

The length of day in the northern latitudes has caused considerable speculation as to its effect on vegetation. According to some, plants should grow 24 hours a day during part of the summer. The length of day, from 15 to 17.5 hours during the growing season at this latitude, is considerably longer than is found only a short distance south. There is no doubt that the vegetation does benefit from the longer day but the extent of such benefit will not be known until the matter is carefully investigated.

If the temperature for a considerable period did not fall below sub-optimum growing conditions no doubt the effect of the long days would be highly beneficial. But according to van't Hoff's law the rate of growth will decrease as the temperature decreases during the night or for longer periods. No matter how long the days the plants will benefit little unless the temperature is high enough to allow for satisfactory growth. This does not mean that in the normal growing season conditions are unfavorable for growth. In June and July ideal weather accompanied by the long days produce ideal conditions. In the late spring and early fall low temperatures are common with the result that the effect of the long days is lessened.

Length of the Frostless Season.

Most ecologists and agricultural writers consider this an important point and frequently quote such data as the average date of the last spring frost, the length of the frostless season, etc. While such data can no doubt be accurately obtained in many places there seem to be large areas, especially in the northern parts, where such data although it can be obtained means practically nothing.

In the first place the standard instrument cage for meteorological work is placed about three feet above the ground level. When the thermometer at this level registers frost the temperature at the ground level may be several degrees lower. Besides this some plants freeze at temperatures slightly below 32° F. while others will withstand much lower temperatures. These are conditions which exist universally.

It is generally accepted that differences in elevation cause differences in temperatures. Robbins (15) reports that in Colorado differences of 1000 feet in elevation cause differences up to 5.2 degrees of temperature depending on the altitude and the time of year. In the Grande-Prairie-Beaverlodge district it would seem that at times differences in local elevation may cause for greater differences than those quoted above. Under certain climatic conditions fairly wide differences in temperature occur at the same time in different habitats. Consequently frost may be expected at certain places every month of the year. This is not the average condition as has been explained before. The question is raised here only to show that ordinary

conditions do not exist in the district under study and that considerable work must be done on this particular problem before anything definite will be known about it.

VIII DISCUSSION OF NATIVE VEGETATION

The Calamagrostis-Pannicularia Association

This association occupies the innermost portion of the grass series in depressions or other low places where the water does not disappear until late in the summer. Calamagrostis canadensis and Pannicularia grandis are the dominant species but C. inexpansa occurs quite frequently. Societies of Beckmannia eruceaformis and Phalaris arundinacea are common especially in moist places where the water does not stand.

The Poa-Agrostis Association

The Calamagrostis-Pannicularia association is usually quite limited in extent. As the habitat gets drier it gives place either to clumps of willow or to such grasses as Poa palustris and Agrostis hiemalis. In some locations the willow represents the beginning of the forest but in many others it gives place to grassland when the habitat becomes drier. This association is found under a wide range of conditions but usually there is plenty of moisture present. Pure stands of the dominant species, Poa palustris and Agrostis hiemalis, are found in many low meadows. On flood plains and beaches it arises when conditions become stable.

Along roadsides and other places where there is plenty of moisture until midsummer societies of Beckmannia eruceaformis, Alopecurus aequalis, Hordeum jubatum, the Calamagrostis spp., and Aira caespitosa are found along with the dominants. The more hydrophytic grasses indicate conditions approximating those which produce the Calamagrostis-Pannicularia association.

The Carex spp. Association.

In some of the depressions or sloughs, especially in the south-west part there is an association of species resembling Carex aquatilis. in appearance. The association is found in a habitat similar to that in which Pannicularia grandis grows. Since no flowering stocks were found neither range nor identity of the species is known. In places it covers large areas and is frequently cut for hay.

The Poa pratensis Association.

Poa pratensis grows under a wide range of conditions. It is usually found where there is fairly good aeration and plenty of moisture. Pure stands occur in meadows which are flooded in the spring but become rather dry by midsummer. In places, probably due to disturbance in the past Hordeum jubatum and Agrostis hiemalis are associated with it. Similarly in one or two situations Agropyron caninum and Hordeum jubatum are found where normally Poa pratensis would be expected.

The Poa-Agropyron Association.

As the habitat becomes drier Poa pratensis gives place to more xerophytic species such as Poa interior and some of the

Agropyrons, Poa interior, Agropyron tenerum, and A. caninum are the dominant grasses in this association. Very seldom are any of these found in pure stands so it is difficult to decide whether or not the association should be subdivided. The association is very widespread and is of great importance owing to the large number of primary and secondary species.

In parts of the sand ridge area where the growth of pine, spruce, and poplar is enough to check the force of the winds this association may be found growing on an ince or two of black soil. The stand is open but the growth is usually luxuriant. In the numerous local depressions Calamagrostis canadensis is the dominant plant but C. inexpansa, apparently a more xerophytic species, is found in the more sheltered parts of the upland. This condition is not found in other parts of the Grande Prairie-Beaverlodge district.

It would seem that in this sand ridge area conditions differ from those in other parts. The usual successions are not found and any that do occur are quite unique. Evaporation is the important factor and the vegetation is quite sensitive to varying degrees of it. Alongside one small spruce bluff for example was found a pure stand of one of the Juncus spp., possibly J. aster, and close by, in a little higher and less protected habitat was found Calamagrostis inexpansa, Bromus ciliatus, Agropyron tenerum and Elymus innovatus. In another place pure stands of Juncus Vaseyi and Stipa spartea were found only fifty feet apart and under apparently the same conditions.

The Koeleria-Agropyron Association.

This association occurs on the drier upland and exposed

situations. The dominant grasses are Koeleria cristata, Agropyron albicans, and A. smithii. Usually each appears to be dominant wherever it is found but all reach their best development under about the same conditions. Both Agropyron albicans and A. inerme are important in certain places, especially near Niobe, but the range appears to be limited. Wherever it has been pastured heavily it gives place to Koeleria cristata, Agropyron smithii, Stipa columbiana and S. spartea are usually found on very exposed and dry places and make little growth. They are also found where plowed land has been allowed to revert to the natural state and where vegetation has been heavily pastured.

The Elymus innovatus Association.

On the more exposed places on the sand ridge area mentioned above pure stands of Elymus innovatus are found. These occupy large areas and are very conspicuous. This grass also occurs throughout most of the other associations wherever there is a medium amount of moisture and good drainage and aeration. On Lake Saskatoon Island pure stands of this grass may be found on the mounds of uprooted trees not more than thirty feet from the water's edge.

The Woodland Transition.

As has been explained before this includes those grasses which grow in habitats where factors such as moisture and light are modified by tree or bush growth. This condition extends over large areas of the district and is very important. No apparent banding exists except where pure grassland gives place to the transition. Within the transition there is a tendency

for the grasses to disappear as the tree growth becomes denser and casts more shade, but the disappearance is more a matter of gradual displacement.

IX GENERAL DISCUSSION

The structure and composition of the grassland resembles that of the "true prairie" of the Mississippi Valley (2, 21) Koeleria cristata and the Agropyron species are important constituents of both while Stipa spartea, the most typical dominant of the "true prairie" and Agropyron smithii occur as species of only minor importance. Andropogon scopiarus and other related species are excluded from the flora by their temperature requirements. The absence of Bouteloua and Bulbilis may be regarded as evidence that "mixed prairie" or "short grassplains" conditions are not present. Similarly the dense sod formed by the grasses is an indication that it cannot be classed as "bunch grass prairie".

The term "parkland" is commonly used when referring to the vegetation of Central Alberta but it has never been exactly defined. Locally it refers to the vegetation of a transition zone between grassland and forest. Within it there may be large areas of grassland with trees and shrubs along streams or in depressions or the latter may be the most prominent feature of the vegetation. To some it is synonymous with the "chaparral" of Colorado and New Mexico. According to Clements (2) and Robbins (15) "chaparral" is a dense growth of shrubs (Quercus spp., Symphoricarpus spp., Amalanchier spp., Prunus melanocarpa, etc.). In the Grande Prairie-Beaverlodge dis-

strict species of Symphoricarpos, Amalanchier, Prunus, etc., form dense thickets in places (especially on Lake Saskatoon Island) but they are more often found in the initial stages of the invasion of grassland by forest. It is possible that these species do form a "chaparral". If so it is distinctly different from the "parkland" as described above.

In discussing the origin of the prairies of Illinois Woodward (31) states that the region has a woodland climate but trees can invade the prairie slowly and only along streams and the borders of forests. Further east the invasion has been more rapid and in many places the prairie has disappeared altogether. The prairies of Illinois have a xerophytic vegetation, a high evaporation, and low soil moisture content during the summer.

Conditions in the Grande Prairie-Beaverlodge district are somewhat comparable. Because of the rolling nature of the land and the numerous lakes and depressions the forest has no difficulty in maintaining its hold once it has become established. In the grassland areas the evaporation must be higher and the soil moisture content lower during the summer since the xerophytic grasses are found only in the more exposed areas. In places where the most xerophytic grasses would be expected species such as Bromus ciliatus, Agropyron tenerum, and Poa pratensis may be found if there are protective topographic or vegetative features nearby which reduce the evaporating power of the wind. Once groves of poplar or willow become established the conditions of the habitat are so modified that even in periods of draught the moisture conditions are such that the trees as well as the more mesophytic grasses are able to main-

tain themselves.

Since meteorological stations are so widely scattered throughout the country it is impossible to determine whether or not this or other areas are subject to less precipitation than the forested areas.

The evaporating power of the Chinook winds in the southern part of the province and their effect on vegetation is well known to those familiar with that region. The Peace River country is also subject to Chinook winds but their duration and frequency are considerably less than in the south.

It would seem, therefore, that the parkland and grassland vegetation are either the result of local differences in precipitation compared with the forested areas together with more exposure to the Chinook winds or of the invasion of prairie areas by forest. The latter appears to be the more logical explanation although there is little evidence to support it. If such is the case the parkland areas of the Peace River country are areas subject to considerably more evaporation than the rest of the country. The succession in the Grande Prairie-Beaverlodge district appears to favor the forest. There is no evidence to show that the present grassland has ever been covered with forest. Most of the area has been burned over in recent years but as in Illinois (31) the grassland has not been produced in this way. Wherever burning has destroyed bluffs or forest the original condition is developed within a short time. There is good evidence that some of the areas now covered with poplar and willow are areas which were forested over but in such cases there is no probability that the climax will be grassland.

X SUMMARY.

This investigation deals with the ecology of the native grasses of the Grande Prairie-Beaverlodge district of the Peace River Country, Alberta, and is based on field and laboratory work covering a period of two years.

The average annual precipitation based on the year (August 1st-July 31st) for a ten year period (1917-1926) varies from 8.24 to 25.05 inches, the average being 16.46 inches.

April and May are the dry months of the year while June, July, and August are the wet months.

On the average a little less than half the annual precipitation comes in the form of snow.

The average mean temperature for December, January and February is 10° F. which is the same as that of north-east Montana, central North Dakota, and central Minnesota.

The average mean temperature for the summer months (June, July, and August) is 57° . The mean monthly temperature for May and September are considerably lower than this.

During the growing season the possible number of hours of bright sunshine daily is from 15 to 17.5.

The evaporation from a free water surface averages 19 inches. This is an indication of the relatively high efficiency with which the precipitation may be utilized by the vegetation.

Districts of similar amounts of precipitation in the Great Plains Region of the United States have "short grass" or "desert scrub" vegetation. Owing to the favorable climatic factors the vegetation of the district is comparable to that of districts in

the United States having from 25 to 40 inches annual precipitation.

Panicum grandis, Calamagrostis canadensis, Agrostis hiemalis, Poa palustris, and P. pratensis are the most important of the lowland grasses of the district.

Poa pratensis, P. interior, Elymus innovatus, Agropyron tenerum, A. caninum, and Koeleria cristata are the important upland grasses.

Many grasses, as Bromus ciliatus, Aira caespitosa, and Agropyron tenerum, grow in habitats modified by the presence of trees and shrubs.

Shallow lakes and depressions have apparently one or two destinies, namely, either a forest or a prairie. Both are seen throughout the entire district.

Available soil moisture and exposure to drying winds are the most important factors determining the structure of the vegetation of the district.

The grassland vegetation of the district is in general similar to that of the "true prairie" of the Mississippi Valley.

From evidence at hand the grassland of the district is very slowly being replaced by forest.

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BEAVERLODGE, ALTA.

TABLE 1
TOTAL PRECIPITATION

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average	Std.Dev.
August	0.47	0.88	1.71	2.14	2.66	2.51	0.54	0.92	4.60	3.50	1.99	1.3
September	0.52	0.21	0.42	1.78	1.80	2.69	1.44	0.37	1.43	2.45	1.31	.85
October	0.56	1.82	0.97	2.18	1.65	0.67	0.61	0.18	1.99	1.61	1.22	.67
November	0.10	0.39	0.55	2.34	0.43	0.91	0.78	0.12	1.43	2.05	0.91	.75
December	1.50	2.60	1.10	1.78	0.75	0.60	0.80	0.50	1.57	2.51	1.37	.72
January	2.50	1.12	0.65	3.85	1.40	1.75	0.70	1.20	1.27	0.50	1.49	.96
February	1.00	1.20	0.70	0.20	0.97	1.75	0.00	0.44	1.79	0.45	0.85	.19
March	0.95	1.36	1.95	2.12	1.20	1.20	1.60	1.40	1.70	0.28	1.38	.50
April	0.37	0.60	0.82	1.82	0.03	0.10	0.23	0.15	0.13	0.66	0.49	.51
May	6.62	0.22	1.04	1.15	1.65	2.11	0.23	0.45	0.93	1.06	0.88	.66
June	1.02	2.29	2.48	3.17	2.04	0.38	1.26	0.60	1.23	4.45	1.89	1.84
July	0.41	3.59	2.22	2.52	1.89	0.44	3.65	1.91	1.38	2.06	2.01	.33
TOTAL	16.02	16.28	14.61	25.05	16.47	15.11	11.84	8.24	19.45	21.58	16.46	4.50

BASED ON THE YEAR AUGUST 1ST TO JULY 31ST.

TABLE II

ANNUAL SNOWFALL

BEAVERLODGE, ALTA.

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
August											
September									5.0	6.4	1.14
October	2.0	9.0	1.75	15.5	1.0		2.0		10.0	14.0	5.50
November	1.0	2.0	5.50	22.0	4.3	4.6	4.0	0.5	10.0	20.5	7.40
December	15.0	26.0	11.00	17.50	7.5	6.0	8.0	5.0	15.7	24.5	13.60
January	25.0	8.75	6.50	38.50	14.0	17.5	7.0	12.0	12.7	5.0	14.70
February	8.0	12.0	7.0	2.0	8.0	17.5	0.0	3.0	17.9	4.0	7.90
March	9.5	12.0	19.50	21.2	12.0	12.0	16.0	14.0	17.0	2.5	13.60
April		4.0	4.0	4.0		1.0		1.5	1.3		0.16
May	10.0					10.0					2.00
June											
July										22.7	2.30
TOTAL	70.50	73.75	65.25	120.70	46.80	68.60	37.00	36.00	89.60	99.60	70.78

BASED ON THE YEAR AUGUST 1ST TO JULY 31ST.

TABLE III

NUMBER OF DAYS SLEIGHING.

BEAVER LODGE, ALTA.

	1916	1917	1918	1919	1920	1921	1922	1923	1924	Average
January	31	31	31	31	31	31	31	31	31	31.0
February	29	28	28	28	29	28	28	26	29	28.1
March	24	31	31	31	31	31	31	26	31	29.6
April		11	14		30	5	7	9	9	9.4
May					6					0.6
June to September										
October		2		10						1.3
November		0		30						3.3
December	14	31	31	31	31	18	29	19	27	25.6
TOTAL	98	134	135	161	158	113	126	111	127	128.9

TABLE IV

AVERAGE MONTHLY MEAN TEMPERATURE

BEAVERLODGE, ALTA.

	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
January	-15.31	2.21	7.29	22.11	2.47	5.95	13.85	5.24	6.75	1.41	27.09	7.19
February	15.88	4.60	8.33	7.66	23.35	19.05	0.19	12.67	20.41	8.50	23.35	13.09
March	17.37	21.36	18.38	10.24	18.94	18.85	16.28	22.83	25.90	21.41	36.23	20.71
April	40.38	34.53	38.03	40.79	27.51	39.53	36.14	37.94	36.30	39.13	42.85	37.56
May	48.11	45.59	45.57	45.01	42.65	48.18	48.30	48.85	51.80	52.90	49.09	48.27
June	57.28	53.31	53.83	51.04	51.54	54.89	57.11	59.18	55.13	57.66	52.84	54.89
July	55.67	59.37	57.70	58.27	62.78	57.86	60.43	59.25	61.00	62.79	60.94	59.64
August	55.66	56.49	56.93	56.40	57.80	55.29	62.24	58.43	54.88	56.80	55.43	56.94
September	49.15	48.05	53.19	50.60	45.75	45.54	50.16	51.55	49.61	46.31	42.65	48.41
October	41.12	36.90	37.40	28.60	36.25	42.54	41.30	44.01	39.97	35.30	39.09	38.41
November	26.38	38.00	26.66	12.60	24.05	16.76	26.63	33.83	23.36	23.81	21.86	24.90
December	6.60	-12.35	19.06	12.64	10.60	17.65	7.79	18.81	2.85	23.01	14.17	10.99
YEAR	33.19	32.33	35.19	32.99	33.64	35.17	35.03	37.72	35.66	35.75	38.79	35.04

TABLE V

SUMMER TEMPERATURE AVERAGES 1916 TO 1921

BEAVERLODGE, ALTA.

YEAR	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1916	51.46	29.30	60.40	35.83	70.05	44.51	66.77	44.58	68.16	43.16	60.44	37.66	51.50	30.74
1917	44.16	24.91	57.00	34.19	64.86	41.76	72.95	45.80	69.90	43.08	61.30	34.80	45.80	28.01
1918	49.60	26.46	58.06	33.09	65.00	42.66	69.37	46.04	67.51	46.35	66.83	39.55	47.48	27.32
1919	51.36	30.23	56.63	33.40	62.46	39.63	70.58	45.97	67.13	45.67	61.56	39.65	58.80	18.41
1920	36.50	18.53	52.66	32.64	62.38	40.70	75.16	50.40	69.70	45.90	56.15	35.36	44.80	27.70
1921	50.13	28.93	59.67	36.69	68.16	41.63	70.77	44.96	66.25	44.33	56.41	34.68	52.19	32.90
1922	45.43	26.86	60.06	36.54	71.20	43.03	75.80	45.06	76.42	48.06	62.16	38.16	52.93	29.67
1923	49.16	26.73	62.19	35.51	71.33	47.03	70.06	48.45	71.48	45.38	65.20	37.90	56.45	29.58
1924	46.37	26.23	65.71	37.90	68.03	42.23	73.84	48.16	66.67	43.09	59.56	39.66	46.68	31.26
1925	49.33	28.93	67.22	38.58	70.46	44.86	75.84	49.74	67.74	45.87	57.10	35.53	44.96	25.64
1926	55.80	29.90	61.51	36.67	63.83	41.86	74.12	47.77	67.77	43.09	53.30	32.00	49.74	28.45
Avg.	48.12	27.00	61.00	35.54	67.07	42.72	72.29	46.99	68.98	44.91	60.00	36.83	48.67	28.15
Means	37.56		48.27		54.89		59.64		56.94		48.41		38.41	

TABLE VI ABSOLUTE ANNUAL RANGE OF TEMPERATURE BEAVERLODGE, ALTA.

YEAR	MINIMUM	MAXIMUM	RANGE
1916	-48.5	83.5	132.
1917	-52.	84.	136.
1918	-36.	89.	125.
1919	-35.	86.	121.
1920	-47.	89.	136.
1921	-30.	80.	110.
1922	-35.	86.	121.
1923	-42.	85.	127.
1924	-41.	91.	132.
1925	-33.	90.	123.
1926	-20.	89.	109.

TABLE VII EVAPORATION FROM A FREE WATER SURFACE. BEAVERLODGE, ALTA.

	1922	1923	1924	1925	1926	Average
April		1.13 (9)			1.41 (13)	
May	2.55 (18)	4.17	4.34 (28)	4.23 (24)	3.07	4.31 [†]
June	5.00	4.08	3.98	4.44	3.45	4.19
July	4.57	3.55	4.64	5.15	5.06	4.59
August	4.26	2.84	2.77	3.63	3.09	3.32
September	2.52	2.37	1.68	2.00	1.69	2.05
October	.94 (21)	1.43 (27)	1.10 (25)	0.33 (17)		.95
TOTAL	19.84	19.57	18.51	19.78	17.77	19.09

THE NUMBER OF DAYS ARE INSERTED IN BRACKETS WHERE RECORDS DO NOT COVER ENTIRE MONTH.
[†] MONTHLY AVERAGE BASED ON AVERAGE RATE FOR PERIOD FOR WHICH DATA IS AVAILABLE.

TABLE VIII AVERAGE MONTHLY EVAPORATION RATES

	<u>BEAVERLODGE, ALTA</u>	<u>FT. COLLINS, COLO.</u>
January		1.3
February		1.59
March		2.88
April		4.26
May	4.31 †	4.62
June	4.19	5.37
July	4.59	5.58
August	3.32	5.00
September	2.05	4.30
October	0.95	3.32
November		1.54
December		1.14

† See footnote to Table VII.

TABLE IX

RELATION OF PRECIPITATION TO

BEAVERLODGE, ALTA.

EVAPORATION FROM A FREE-WATER SURFACE.

Year	Period	Precipitation for Period	Evaporation for Period	Total Precip- itation for Year
1922	May 13" - Oct.21"	3.46	19.84	15.11
1923	Apr.21" - Oct.27"	6.63	19.57	11.84
1924	May 3" - Oct.25"	10.78	18.51	8.24
1925	May 7" - Oct.17"	9.69	19.78	19.45
1926	Apr.17" - Sept.30"	10.37	17.77	21.58
Average		8.19	19.09	15.24

TABLE X.HOURS SUNSHINE.BEAVER LODGE, ALTA.

	1924	1925	1926	Possible
January	81.4	73.3	77.5	245.
February	112.4	101.2	73.7	280.
March	150.3	163.1	162.9	367.
April	205.0	236.3	226.5	423.
May	279.8	358.2	276.3	483.
June	268.7	299.9	264.7	517.
July	253.9	302.3	321.1	517.
August	213.8	193.0	242.2	462.
September	158.1	176.7	144.2	382.
October	104.6	131.4	124.8	323.
November	80.2	111.8	65.8	254.
December	91.4	39.1	77.3	226.
TOTAL	2000.0	2186.0	2057.0	4479.

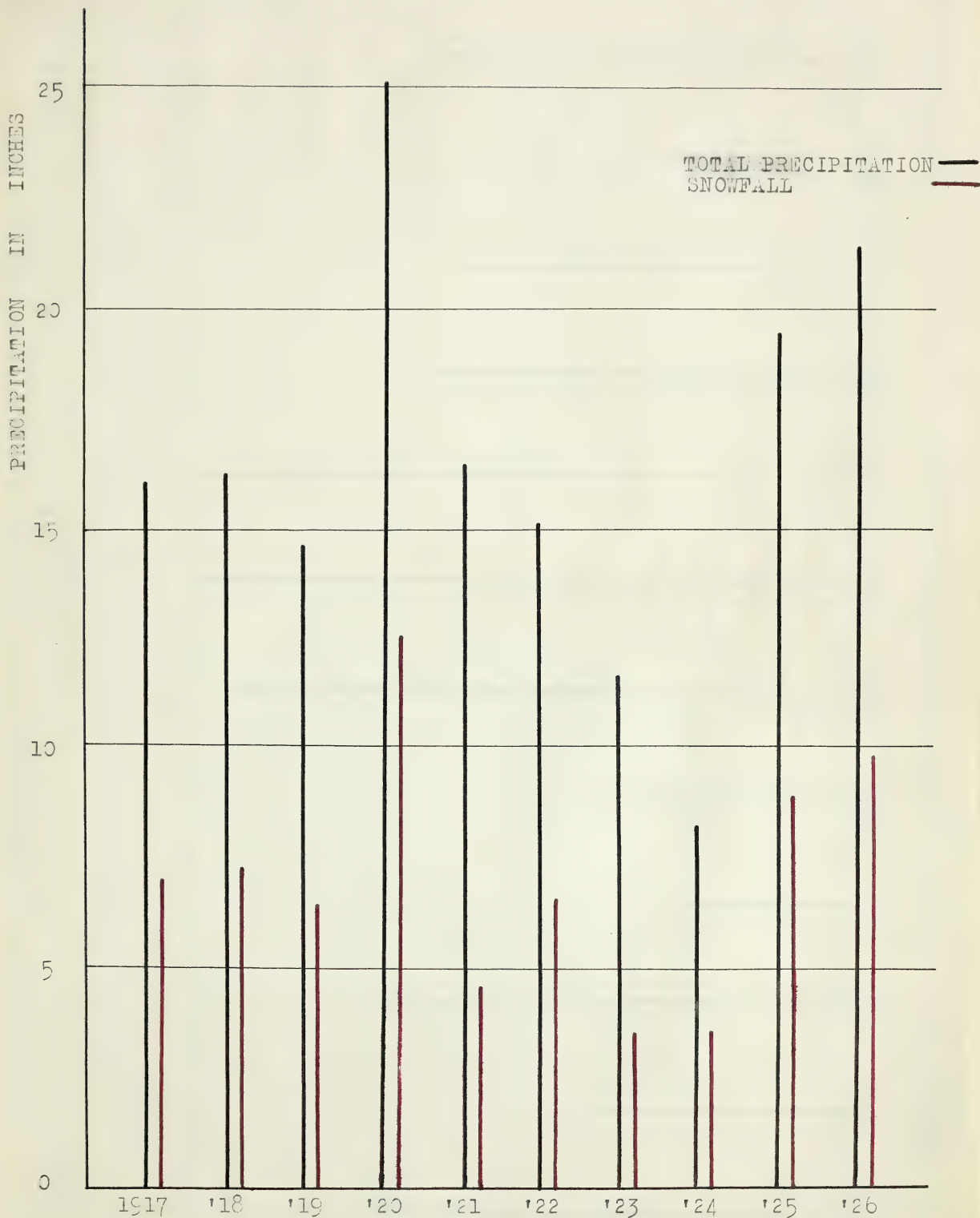


FIGURE 1. YEARLY RANGE OF PRECIPITATION. BEAVERIDGE, ARIZ.
BASED ON THE YEAR AUGUST 1-JULY 31.

PRECIPITATION IN INCHES

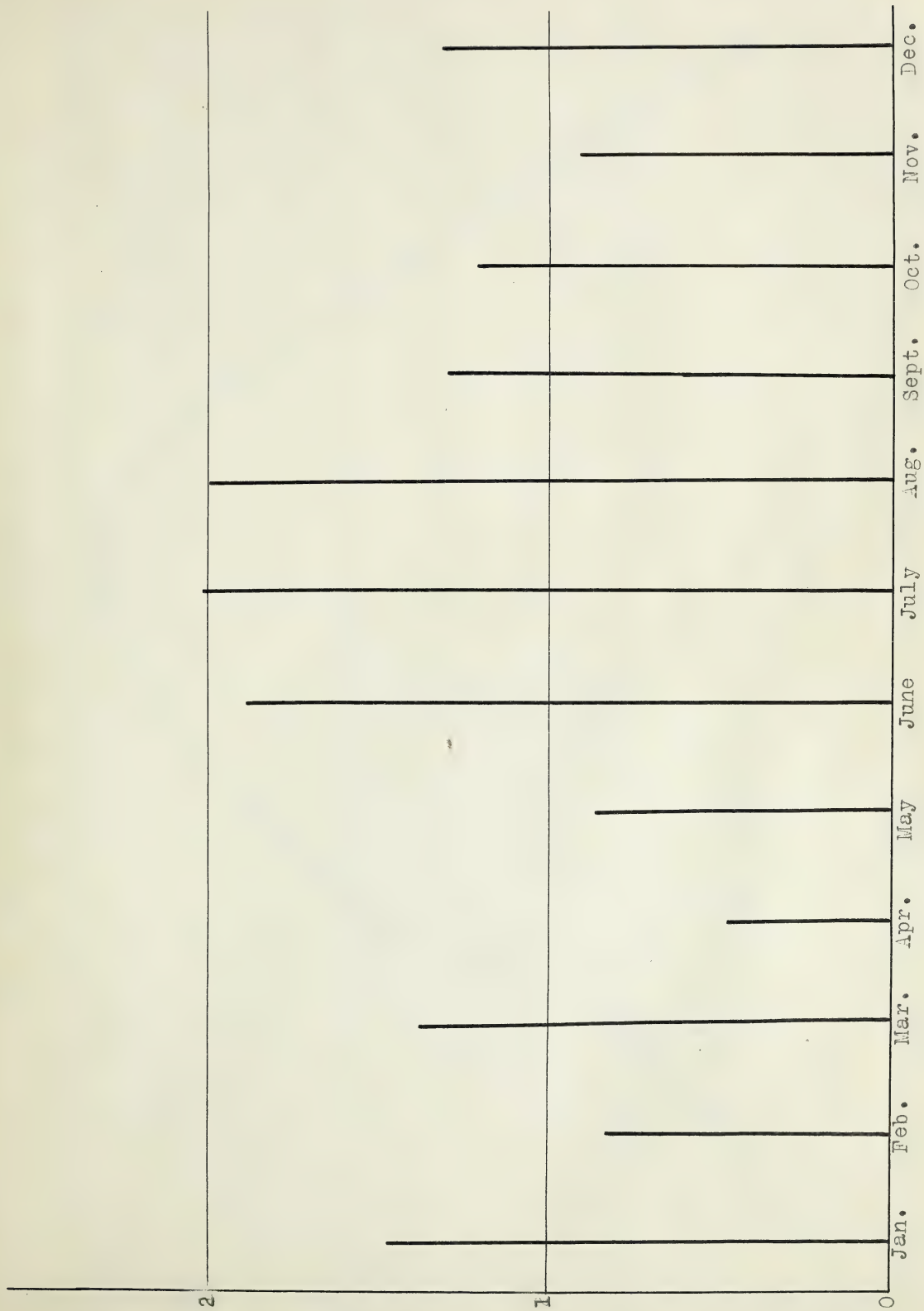


FIGURE 2

AVERAGE MONTHLY PRECIPITATION

BEAVERLODGE, ALTA.

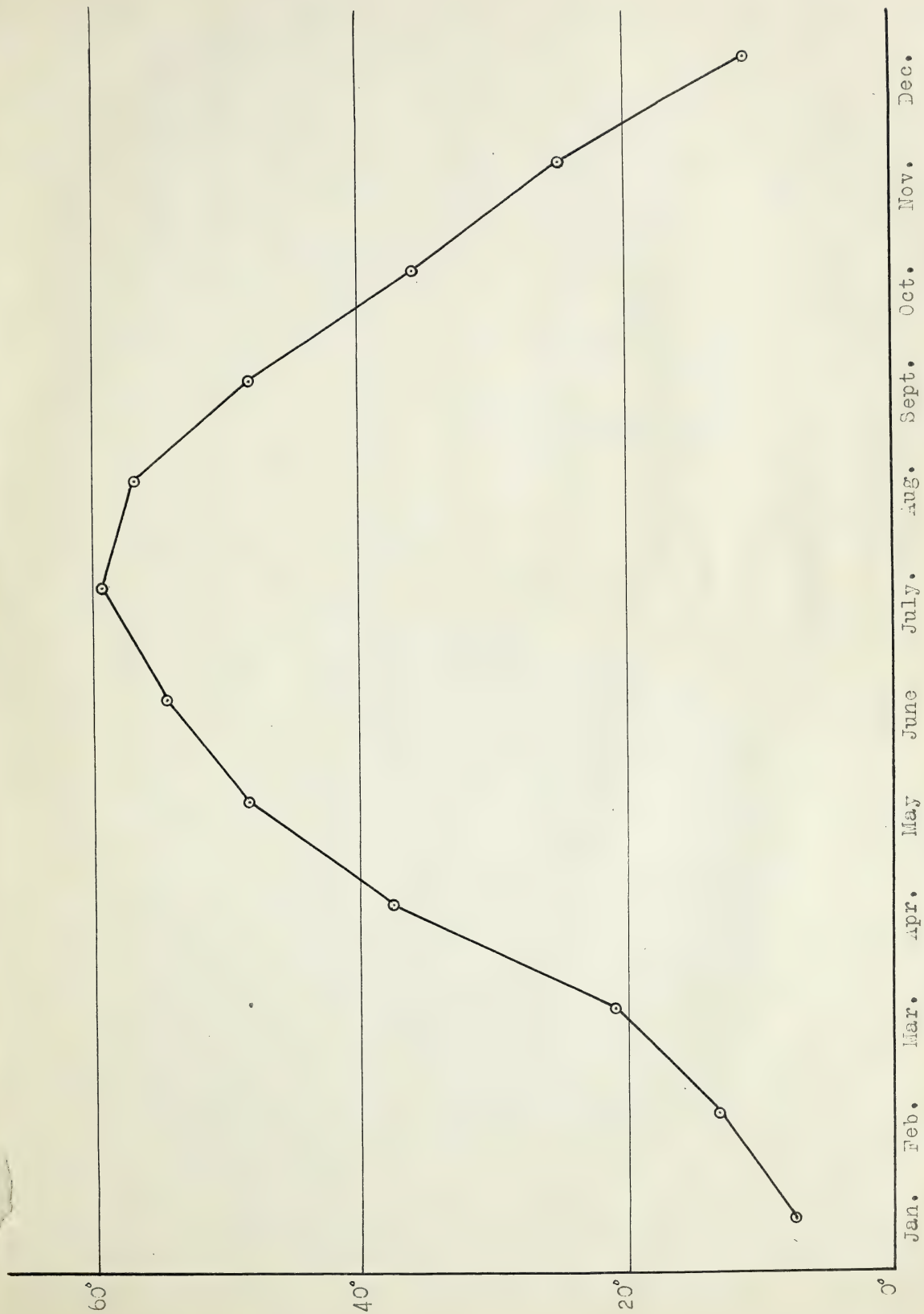


FIGURE 3
AVERAGE MONTHLY MEAN TEMPERATURE

BEAVERLODGE, ALTA.

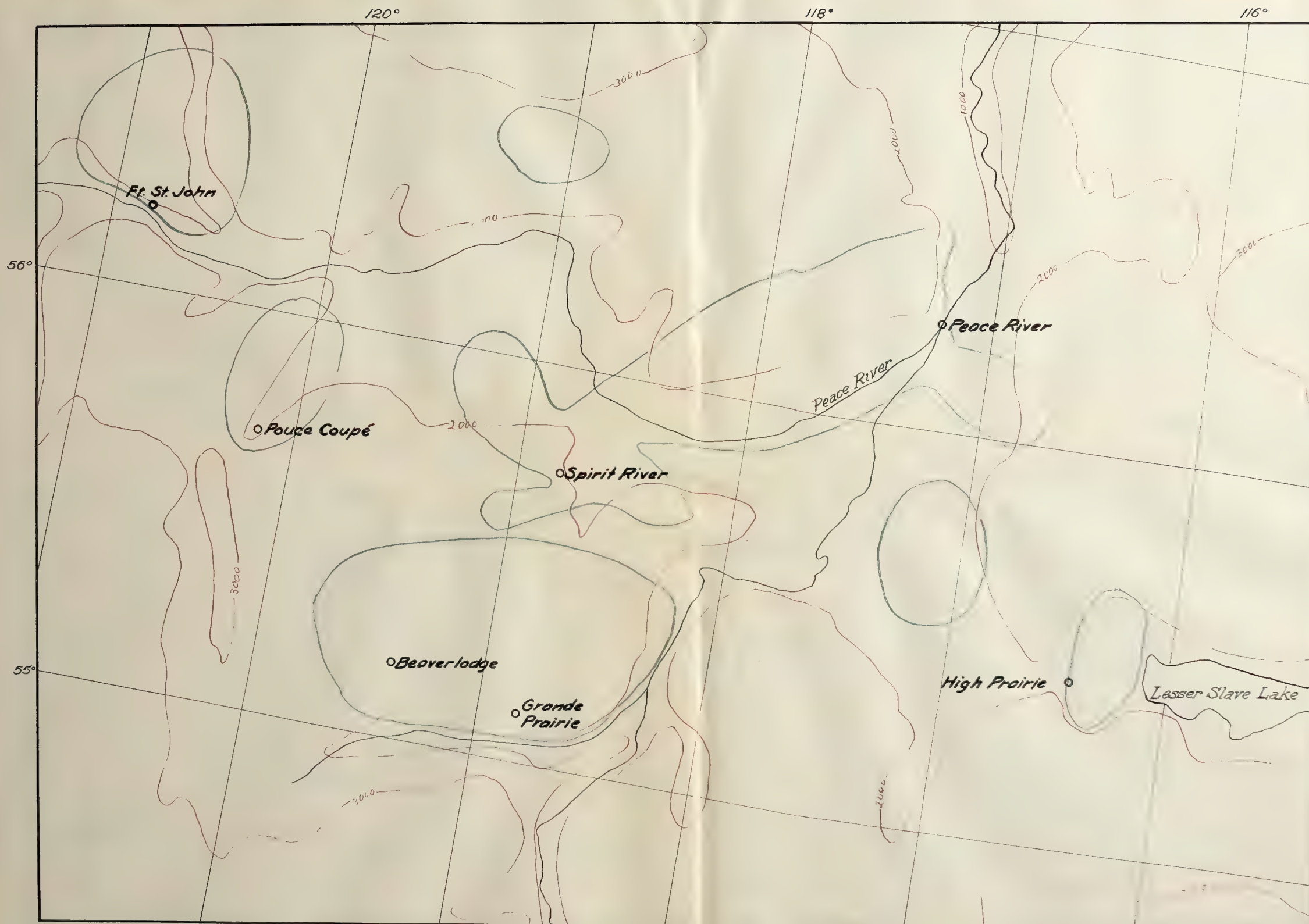


Figure 4. THE PARKLAND AREAS OF THE PEACE RIVER COUNTRY

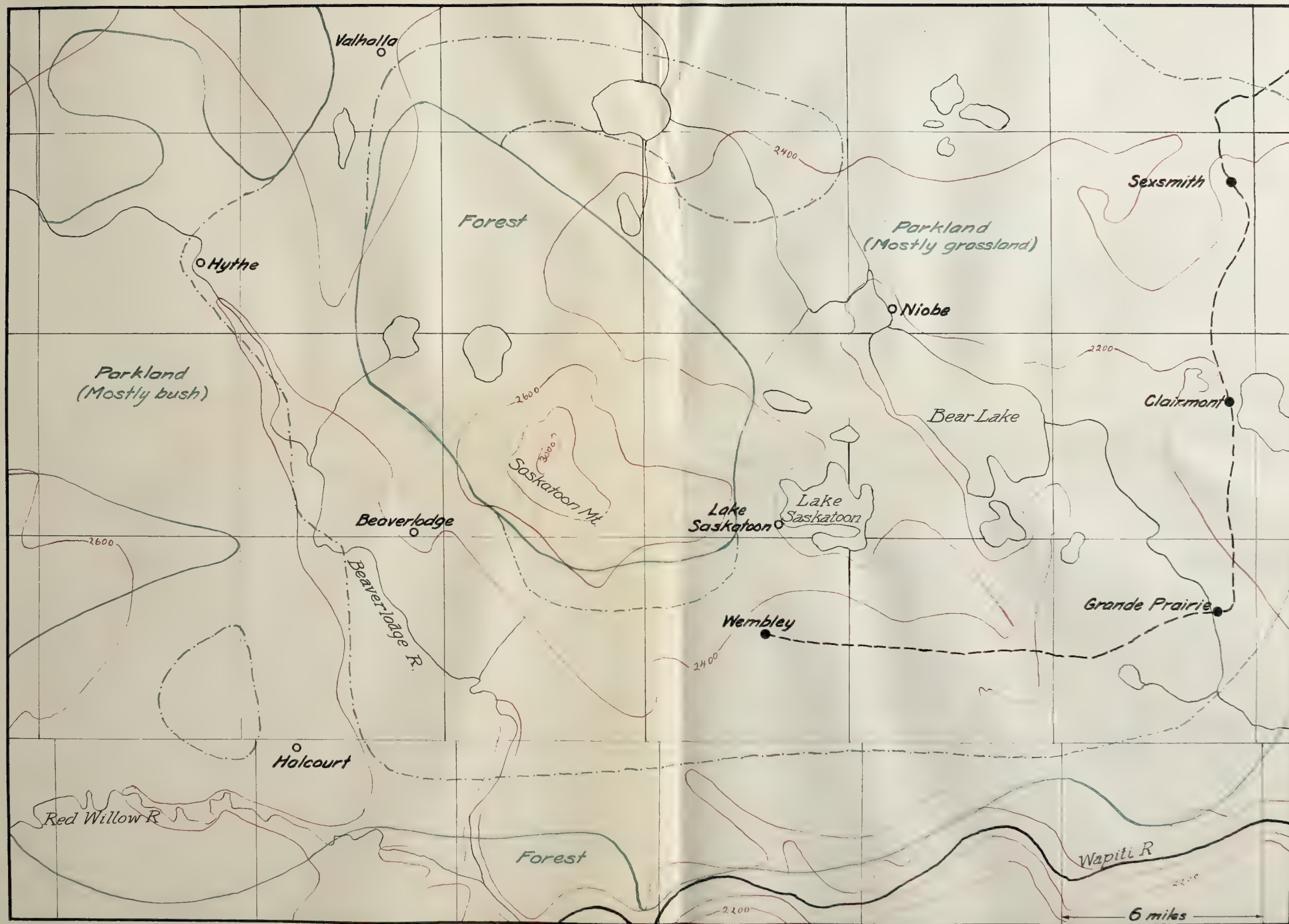


Figure 5. THE GRANDE PRAIRIE - BEAVERLODGE DISTRICT

